LONGITUDINAL ANALYSIS OF THE ROLE OF INSOMNIA IN SUICIDE RISK AMONGST SUICIDE IDEATORS AND ATTEMPTERS

by

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STATEMENT OF THESIS APPROVAL

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ABSTRACT

Currently, identification of proximal risk factors of suicide is a primary focus of suicide research; however, knowledge of these risk factors is limited. Therefore, longitudinal studies aiming to identify proximal, time-varying predictors of suicidal behavior are needed to improve prediction and prevention of suicide behaviors. To date, several studies have reported significant associations among insomnia, suicide ideation, and suicidal behaviors. This study sought to examine the relationship between insomnia (ISI) and suicide risk (BSS) over time amongst a group of suicide ideators, single, and multiple suicide attempters who took part in a clinical trial comparing treatment as usual (TAU) to brief cognitive behavioral therapy (BCBT). Participants included 152 active-duty Army soldiers reporting past week suicide ideation with some intent and/or past month suicide attempt. Longitudinal growth modeling was used to test the effect of trajectories of variables, as well as to compare group means. Additionally, a two-intercept cross-lagged panel over time was created to determine if insomnia and suicide scores risk predict change at the next time point. BCBT participants experienced a significant negative trajectory of ISI, while TAU's trajectory was nonsignificant. Suicide ideators and single attempters reported similar baseline and end-of-study levels of ISI. No differences in ISI trajectories were observed between suicide status groups. A two-intercept cross-lagged panel over time was created to model the ability of previous BSS and ISI scores to predict change in the following time points. Previous variable

measurements (t-1) significantly predicted change in following like-measurements, but did not predict change in the other variable (i.e., t-1 ISI did not predict change in BSS, t-1 BSS did not predict change in ISI). Results of analyses revealed that suicide status groups report similar baseline levels of insomnia and suicide risk; suicide status groups have similar trajectories in insomnia over time; and while insomnia and suicide risk change together over time, change in one does not predict change in the other. Overall, these findings suggest that insomnia is a co-occurring problem with suicide risk for individuals with suicidal thoughts and behaviors, but it does not influence fluctuations in suicide risk.

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INTRODUCTION

In 1999, the Surgeon General submitted a *Call to Action* to prevent suicide (U.S. Public Health Service, 1999). Since then, dozens of research studies have focused their efforts on identifying risk and protective factors for suicide attempts, correlates of suicide ideation, and treatments to prevent suicide (see Nock et al., 2013 for a review of psychosocial risk factors of suicide in military personnel). Unfortunately, predictors of suicide ideation (the modal studied outcome) do not help us predict who will attempt suicide because risk factors for suicide ideation and attempt differ (Klonsky & May, 2014), and research aimed at identifying predictors of the transition from suicide ideation to attempt is sparse (Chen, Shamsul, & Manjam, 2014). Additionally, the majority of epidemiological and psychological studies use nonspecific, stable, and/or trait-based variables to predict suicide ideation and death (e.g., Borges et al., 2006; Borges et al., 2010; Kessler, Borges, & Walters, 1999). It is critical that we are able to identify those at risk for suicide attempt quickly because the first year of experiencing suicide ideation carries the greatest risk for a suicide attempt (Oquendo et al., 2004) and the first 6 months after receiving treatment for suicide confer the greatest risk (Chan, Shamsul, & Maniam, 2014; Rudd et al., 2015).

Despite the consistent support for a broad range of sociodemographic and psychological risk factors of suicide, the literature lacks studies appropriately designed to draw conclusions about factors that *predict* future suicide attempts. Many studies have

focused on understanding suicidal thoughts and behaviors by measuring associations among risk variables with *past* suicidal thoughts and behaviors. However, in order to more accurately understand and predict suicide, we must identify those variables that contribute to, or increase risk in, the period of time leading up to the emergence of suicidal behavior. Retrospective reports do not allow us to obtain that information. Therefore, future research must employ appropriate prospective methodologies with the intent to identify near-term or imminent risk factors associated with the transition from suicidal thought to action. However, using a baseline variable to "predict" suicide that occurs at some point over the course of a longitudinal study is insufficient. Predictors and outcomes need to be measured simultaneously over multiple time points in order to allow for identification of helpful, short-term risk factors, as well as their temporal relationships with the emergence of suicidal behaviors. Additionally, long-term, sociodemographic risk factors of suicide, while informative of who is *more likely* to attempt suicide, yield only marginal information in the prediction of when a suicide attempt will occur. Dynamic predictors that change over time, on the other hand, may be more informative predictors of short-term risk. However, studies examining such variables and their temporal influences are currently limited (Glenn & Nock, 2014).

Additionally, it has been suggested that single and multiple attempters should be considered separately (e.g., Boisseau et al., 2013; Monnin et al., 2012); however, many studies have neglected to make this distinction (Forman, Berk, Henriques, Brown, & Beck, 2004; Monnin et al., 2012). *Single attempters* are defined as those who have made one suicide attempt in their lifetimes, while *multiple attempters* have made at least two lifetime suicide attempts. Approximately half of attempters have made previous attempts

(Chastang, Rioux, Dupont, Kovess, & Zarifian, 1997; Monnin et al., 2012; Scoliers, Portzky, van Heeringen, & Audenaert, 2009), suggesting that after an individual makes their first suicide attempt, there is a 50% chance they will attempt suicide again. Given that multiple suicide attempts is the most robust predictor of future suicidal behavior (Bryan & Rudd, 2006; Joiner et al., 2005), it is imperative that we be able to distinguish single from multiple attempters. Multiple attempters may report more severe suicide ideation than suicide ideators and single attempters who report similar levels of suicide ideation (Forman et al., 2004; Rudd, Joiner, & Rajad, 1996), and be less likely to regret their attempts (Forman et al., 2004), placing them at higher risk. Risk factors for multiple suicide attempts may include female gender, young age, low socioeconomic status (Rudd et al., 1996; Scoliers et al., 2009), higher severity of psychopathology and comorbidity (Forman et al., 2004; Hawton, Houston, Haw, Townsend, & Harris, 2003; Monnin et al., 2012), specifically, higher rates of borderline personality disorder (BPD) and impulsivity (Boisseau et al., 2013; Borges et al., 2010), more complicated childhood (Forman et al., 2004), and poor interpersonal functioning (Forman et al., 2004). Although these risk factors have been identified as predictors of multiple attempter status, they are also very nonspecific, as demonstrated by research indicating that demographic factors have limited utility in distinguishing single from multiple attempters (Boisseau et al., 2013; Forman et al., 2004; Michaelis et al., 2003).

Currently, identification of proximal risk factors of suicide attempt is a primary focus of suicide research. To date, knowledge of proximal risk factors is limited, although a multitude of studies have reported significant associations among insomnia, suicide ideation, and suicidal behaviors (e.g., Chakovatory et al., 2014; Fawcett et al.,

2014; Krakow, Ribeiro, Ulibarri, Krakow, & Joiner, 2011). The most recent edition of the DSM (DSM-5; APA, 2013) characterizes insomnia as a sleep-wake disorder marked by persistent trouble falling asleep, maintaining sleep, or waking earlier than expected, which result in daytime impairment. Insomnia is to be distinguished from sleep disturbances more broadly, which may refer to hypersomnia, narcolepsy, or other sleep-related complaints. A developing body of work suggests that insomnia may be a short-term predictor of suicide. Several large, international, longitudinal studies have reported that after controlling for the effects of various demographic variables and health risks, individuals with insomnia are at a 2.4 to 4 time higher risk of dying by suicide than those without insomnia (i.e., Bjorngaard, Bjerkeset, Romundstad, & Gunnell, 2011; Fujino, Mizoue, Tokui, & Yoshimura, 2005; Gunnell et al., 2013). Unfortunately, these longitudinal studies did not report average times between experience of insomnia and eventual suicide. Additionally, Chakrovatory and colleagues (2014) found that insomnia predicted which veterans endorsed suicide ideation and had made a suicide attempt in the past year, and Fawcett et al. (1990) found that anxiety, insomnia, and anhedonia predicted suicide within a year, whereas hopelessness and suicide ideation predicted suicide in the next 2 to 10 years. Pigeon, Britton, Ilgen, Chapman, and Conner (2012) completed psychological autopsies on veterans that had visited a medical center in the year prior to their suicides. They found that those reporting insomnia died significantly sooner than those who did not report insomnia. Specifically, those with insomnia died on average $2^{1/2}$ months after their last medical center visit, whereas those who did not report insomnia died about 7 months later. In other words, these findings suggest that insomnia may be proximal risk factor of suicide. This is the shortest time window reported

between suicide and an associated risk factor that was identified after a thorough review of the literature. However, this study had several limitations that warrant continued investigation of insomnia as a promising indicator of short-term suicide risk.

Although the relationships between insomnia and suicidal thoughts and behaviors are well-supported, the specific role that insomnia plays in the transition from suicide ideation to suicidal behavior remains unclear due in part to a lack of understandings of the mechanisms that drive their relationship (Winsper & Tang, 2014) and the omission of insomnia-related measures in clinical trials assessing the efficacy of various treatments for the prevention of suicide ideation and attempts (e.g., Brown et al., 2005; Linehan et al., 1999; Linehan, Comtois, Brown, Heard, & Wagner, 2006; Stanley, Brodsky, Nelson, & Dulit, 2007; Wang et al., 2015). Furthermore, clinical trials focused on assessing insomnia interventions often exclude individuals with current suicide ideation or a history of suicide attempt (e.g., Edinger et al., 2009; Pigeon & Funderburk, 2014) or do not measure suicide ideation or behaviors (e.g., Germain et al., 2014; Trockel, Karlin, Taylor, & Manber, 2014). However, one recent study examining the efficacy of cognitive behavioral therapy for insomnia (CBT-I) in a group of 405 veterans found that significantly fewer participants reported suicide ideation upon treatment completion (Trockel et al., 2015). After controlling for the effects of demographic variables, each 7-point decrease in insomnia predicted a 65% reduction in odds of suicide ideation. Insomnia may therefore be a promising target of focused attention among suicidal individuals for several reasons: (1) its ability to be measured prospectively and to be observed over time, (2) its relatively high incidence rate, (3) its responsiveness to manipulation and intervention (Morgenthaler et al., 2006; Smith, Huang, & Manber,

2005), and (4) growing evidence that treatment for insomnia decreases suicide ideation (i.e., Trockel et al., 2015).

In order to address the current methodological limitations in the literature, this project has examined the temporal relationship between insomnia and suicide risk in the context of a randomized controlled trial with 2 years of follow-up data. Further, this study sought to determine if these trajectories differ amongst three suicide status groups (SSGs): suicide ideators, single attempters, and multiple attempters. It was hypothesized that insomnia symptoms would be statistically equivalent between treatment groups at baseline and over the course of the study, but that multiple suicide attempters would report higher baseline and 18-month insomnia than suicide ideators or single attempters, as well as showing stronger rates of change. Finally, insomnia symptoms were expected to predict change in suicide ideation but not the reverse (see Figure 1), and this pattern was hypothesized to be consistent across SSGs.

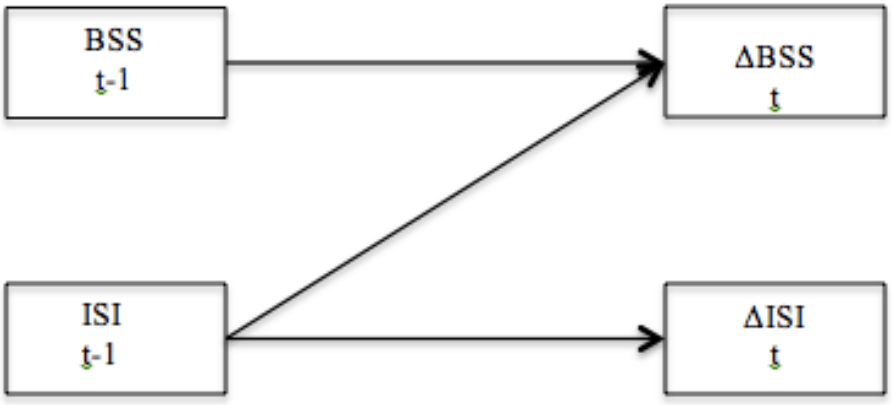

Figure 1. Hypothesized temporal relationship between insomnia and change in suicide ideation.

METHOD

The following study has used data from a recently published randomized controlled trial that assessed the efficacy of brief cognitive-behavioral therapy (B-CBT) in a sample of active-duty soldiers. The methods are the same as those described in Rudd et al. (2015). More extensive demographic data and descriptions of the procedures are available in the original manuscript.

Participants

Active-duty soldiers were eligible for participation if they reported past week suicide ideation with intent to die and/or a suicide attempt in the past month, were at least 18 years of age, spoke English, and were capable of providing informed consent. Past week suicide ideation with intent to die was measured with the self-report Beck Scale for Suicide Ideation (Beck, 1991). To satisfy eligibility criterion, participants were required to score at least 5 on this scale. History of suicide attempts was assessed by the clinician-administered Suicide Attempt Self-Injury Interview (SASII; Linehan, Comtois, Brown, Heard & Wagner, 2006). Trained clinicians determined if reported events qualified as suicide attempts based on the following definition: self-directed injury with some intent to die. Soldiers experiencing medical or psychological problems that could prevent his/her ability to provide informed consent or participation in outpatient treatment (i.e., psychosis or mania) were excluded from participation.

For the purposes of these analyses, participants were grouped on their baseline suicide history, or suicide status group (SSG). Participants reporting suicide ideation without history of an attempt were included in the *suicide ideator* group. Those reporting a history of suicide attempt were separated into *single attempters* (history of one suicide attempt) and *multiple attempters* (history of more than one suicide attempt).

Participants included 152 active-duty Army soldiers (86.9% male, 13.1% female) ranging in age from 19 to 44 years (M= 27.53, SD= 6.26) referred by their behavioral health clinicians, identified by emergency department reports, or had been admitted to an inpatient psychiatric unit at a Midwestern United States Army base, due to suicide ideation or a suicide attempt. The majority of the sample identified as Caucasian (70.9%) and non-Hispanic (78.3%). Rank distribution was 73% junior enlisted (E1-E4), 22.9% noncommissioned officer (E5-E6), 3.5% senior noncommissioned officer (E7-%9), and 0.6% warrant officer. Participants had deployed between zero and eight times, 81% having deployed at least once.

Procedures

Participants were randomly assigned to one of two treatment arms: brief cognitive behavioral therapy (BCBT; n=76) or treatment as usual (TAU; n=76). All participants were allowed to continue receiving any mental health or substance abuse treatment during their participation in this trial. Additionally, upon completion of BCBT, participants were able to continue mental health treatment with another provider if they desired to do so. Clinician-administered interviews and self-report measures were administered in-person at baseline. Additionally, self-report measures and interviews

assessing occurrence and severity of suicide ideation and suicide attempts were conducted 3, 6, 12, 18, and 24 months after baseline assessment.

Measures

All self-report measures were completed in-person. Clinician-administered interviews were completed either in-person or over the phone by a trained and blinded evaluator. Interview measures were monitored, and evaluators received supervision from a lead investigator. Interrater reliability was very good (κ=.96).

Suicide status group. Suicide attempt history was evaluated with the SASII (Linehan et al., 2006), a clinician-administered interview that assesses several facets of self-injurious behaviors including suicide intent, desired and expected outcome of suicidal behaviors, and lethality of attempts. Participants were labeled as suicide ideators, single, or multiple attempters based on the results of this interview. Interrater reliabilities of assessor-rated items across four studies are excellent, ranging from 0.87 to 0.98 (Linehan et al., 2006).

Suicide risk. The Beck Scale for Suicide Ideation (BSS; Beck & Steer, 1991) is a 19-item self-report measure of the intensity of current (past week) attitudes, behaviors, and intentions to commit suicide (Beck & Steer, 1991). This measure does not have clinical cutoff scores, but item totals greater than 0 indicate the presence of suicide ideation and as scores increase, suicide desire is more severe. Convergent validity between patient and clinician-scored versions is greater than .90 (Beck, Steer, & Ranieri, 1988) and internal reliability estimates range from .87- .97 (Beck & Steer, 1991; Steer, Kumar, & Beck, 1993).

Insomnia. Insomnia symptoms were measured with the Insomnia Severity Index (ISI; Morin, 1993). The ISI is a 7-item self-report measure of symptoms and consequences of insomnia, as well as related-subjective distress scored on a 5-point likert scale. Each item is scored with the lowest response indicating no trouble and the highest response indicated the most trouble. Scores ranging from 0 to 7 suggest the lack of insomnia, 8 to 14 suggest subthreshold insomnia, 15 to 21 suggest moderate clinical insomnia, and 22 to 28 suggest severe clinical insomnia. The ISI has been demonstrated to have adequate reliability and validity (e.g., Bastien, Vallères, & Morin, 2001; Morin, Belleville, Bélanger, & Ivers, 2011), sensitivity to changes in insomnia (e.g., Bastein et al., 2001; Morin et al., 2011), and convergent validity with clinician-rated versions (Bastien et al., 2001) and similar constructs (Morin et al., 2011).

Statistical analyses

Descriptive analyses of the study sample were completed with SPSS version 22-software (IBM Corporation, 2013). Chi-square analyses were used to confirm that genders, histories of nonsuicidal self-injury, and treatment assignments were equally represented across suicide status groups. Additionally, one-way ANOVAs were computed to evaluate group differences in demographic characteristics (i.e., age). Subsequent analyses used multilevel modeling (MLM) and HLM7 software (Raudenbush, Bryk, Cheong, Congdon, & du Toit, 2011) with restricted maximum likelihood estimation procedures. MLM is appropriate for this study for several reasons including: 1) It is used when there is dependence amongst the data (e.g., multiple assessments of an individual), 2) it allows between- and within-person effects to be modeled simultaneously,

and 3) it is robust to missing data at the assessment (level one) level (Raudenbush & Bryk, 2002; Jackson, 2010). Importantly, this modeling technique examines the effect of change over time, or trajectories, of variables. The present study assessed participants at six time points over 24 months, and sought to understand how variables influence each other over time. Variables are not only expected to change together, but influence change in the following assessments, justifying the use of longitudinal growth modeling as opposed to repeated measures analyses.

Level one data included estimates of intraindividual change over time while level two data accounted for systematic differences between individuals. Prior to analyses, age (in years) was centered around the sample's average age, and contrast codes were created to allow for planned comparisons between SSGs. Equations including "SS1" compared multiple attempters (coded -.667), to suicide ideators and single attempters (each coded .333), as multiple attempters have been reported to be different from the other two groups (Rudd et al., 1996). The second contrast compared single attempters (coded -.5) to suicide ideators (coded .5). Time was measured by the number of months the assessment occurred since baseline (coded 0). The trajectory of symptom change over time was evaluated to determine the appropriateness of a linear effect of time. An intent-to-treat approach, or inclusion of all participants regardless of completeness of participation or attrition, was used. To determine the impact of treatment assignment and baseline SSG status on insomnia over time, as well as to model the relationship between insomnia and suicide risk over time, longitudinal growth models were used. Finally, a two-intercept cross-lagged panel over time with SSG as a candidate moderator variable was created to determine if change in insomnia and suicide risk predict scores at the next

time point. Two-intercept cross-lagged panels allow for the estimate of simultaneous, yet distinct effects of each of the predictors (i.e.,, suicide risk and insomnia). The moderating effect of suicide status was tested, but nonsignificant, indicating that patterns of findings were comparable across all groups. All equations are referenced in brackets throughout the results section and have been listed in the Appendix.

RESULTS

Averaged scores of ISI were plotted over time for both treatment groups (Figure1) and SSGs (Figure 2). BIC values of linear [1,2,3] and quadratic models [4,5,6] were compared to determine the best fitting model to the data. Comparable BIC values were observed between linear and quadratic models examining ISI differences between treatment groups (linear BIC= 2270.18, quadratic BIC= 2270.84) and suicide status groups (SS1 linear BIC= 2270.09, quadratic= 2275.68; SS2 linear BIC= 2267.07, quadratic= 2282.61); therefore, only a linear effect of time was included [i.e.,, 1,2,3]. There was no evidence for the inclusion of a polynomial effect of time or treatment by time interaction in models predicting BSS [i.e., 7,8].

Treatment effects on insomnia

A significant linear time by treatment group interaction was observed (B = -0.29, p= 0.004), specifically, participants in the BCBT group reported in a 0.29 reduction in ISI at over time [1]. Analysis of simple slopes revealed that B-CBT participants experienced significant negative trajectory of ISI (B = -0.29, p< 0.001), while TAU's trajectory was nonsignificant (p= 0.07). BCBT and TAU participants reported nearly identical average ISI at baseline (B = 0.51, p=0.60); however, TAU participants' ISI levels immediately increased posttreatment while BCBT participants continued to show a decline in ISI

through 12-months posttreatment (see Figure 2). As a result of the significant treatment by time interaction, treatment group was included as a covariate in the following analyses.

Sample characteristics and baseline suicide status group differences

At baseline 40.1% (*n*= 61) of participants were multiple attempters, 42.8% (*n*= 65) single attempters, and 17.1% (*n*= 26) were suicide ideators. Suicide status groups were equally assigned to TAU and BCBT by randomization (see Table 1). Overall, our SSGs were similar at baseline, with gender evenly represented, and similar average ages and levels of education (*p*'s> 0.05). However, multiple attempters were more likely to have a history of nonsuicidal self-injury (NSSI). Therefore, NSSI-history was included as a covariate in models comparing multiple attempters to other SSGs [i.e., 6,7,10]. Due to the potential effect of partialing out important variance in what distinguishes multiple from single attempers, models were repeated without NSSI-history as a covariate. Results were unchanged; therefore, coefficients with the covariate included are reported. Suicide ideators and single attempters reported similar baseline levels of BSS (*M*=8.30(8.37); *M*= 10.13(8.96); B = 0.84, *p*= 0.59 [7]), as did ideators and single attempters compared with multiple attempters (BSS *M*= 10.05(8.54); B = -0.15, *p*= 0.89 [8]). Similar BSS scores were observed between groups when analyses were repeated with suicide status group categorized by status at the end of the study.

Suicide status group differences in change in insomnia over time

Suicide ideators and single attempters reported similar baseline levels of ISI (*M*= 18.68 (5.93); *M*= 16.18 (6.04), respectively; B = 2.22, *p*= 0.08 [2]). Multiple attempters

also reported similar baseline ISI as ideators and single attempters (ISI *M*= 18.86(6.93), B = -0.04, *p*= 0.97 [3]). Additionally, time was centered at 18 months to determine if final ISI was different amongst SSGs after controlling for the effects of treatment and NSSI status (for multiple attempter comparison). All groups were statistically equivalent in 18-month ISI (*p*'s > 0.05 [9,10]). A plot of insomnia severity (see Figure 3) and longitudinal growth models [2,3] were constructed to understand the change in insomnia over time amongst the SSGs. Again, treatment assignment and baseline NSSI status were included as covariates in these models. No differences in linear or quadratic ISI trajectories were observed between SSGs (*p*'s >.05), suggesting that SSGs reported similar rates of change as well as trajectories in ISI over time. These results held when final SSG (rather than baseline SSG) was used as a predictor.

Cross-lagged panel predicting change in suicide risk and insomnia over time

A two-intercept cross-lagged panel over time was created to model the ability of previous BSS and ISI scores to predict change in the following time points. Previous variable measurements significantly predicted change in following like-measurements, but did not predict change in the other variable (i.e., t-1 ISI did not predict change in BSS, t-1 BSS did not predict change in ISI). Additionally, the resulting model was consistent across SSGs (see Figure 4) [11].

Table 1

Characteristics of suicide status groups

	Suicide ideator	Single attempters	Multiple attempter	Test statistic
BCBT	11	33	32	X^2= 0.78
NSSI history	13	14	26	X^2= 6.24*
Age	29.43 (6.97)	26.99 (6.02)	26.89 (5.94)	F= 2.46

Note. Frequencies are reported for X^2 tests. Means and standard deviations (in parentheses) are

presented for ANOVA tests.

*p <0.05

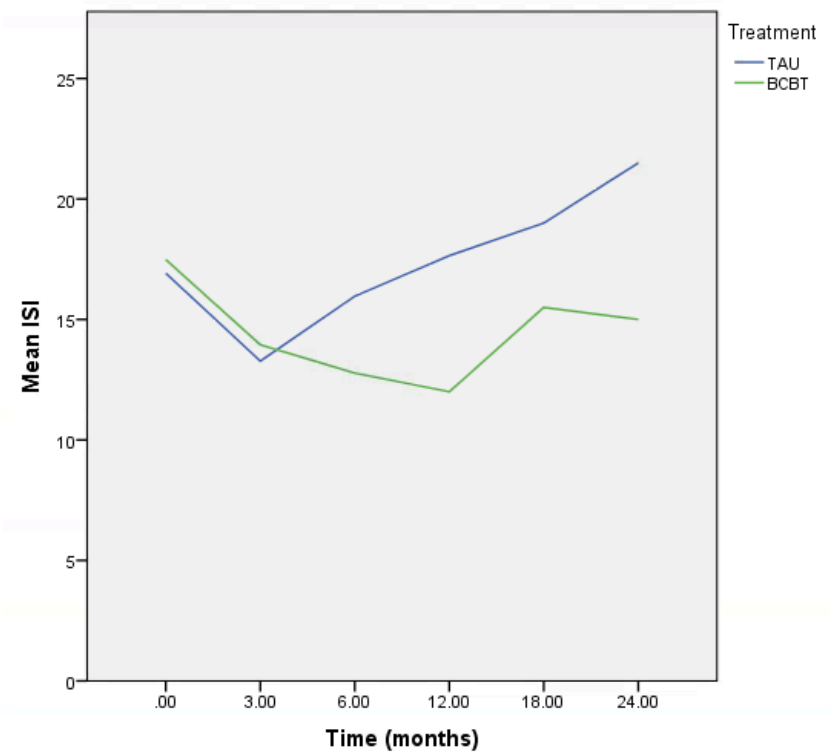

Figure 2. Growth in insomnia over time by treatment condition

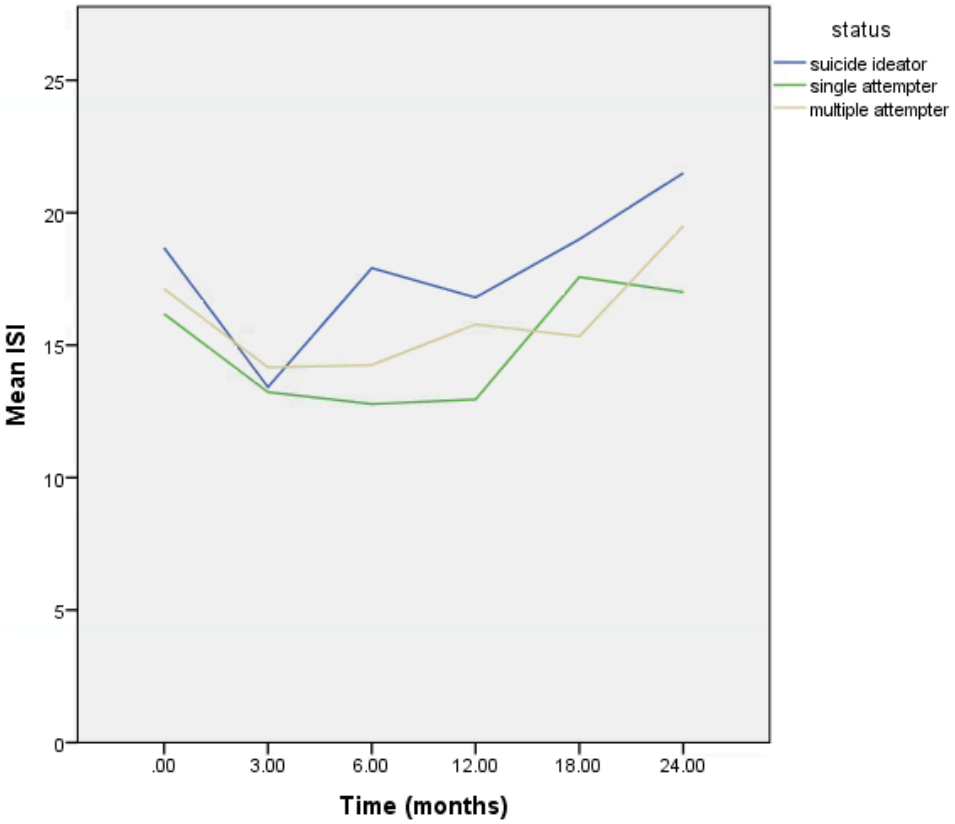

Figure 3. Growth of insomnia in suicide status groups over time

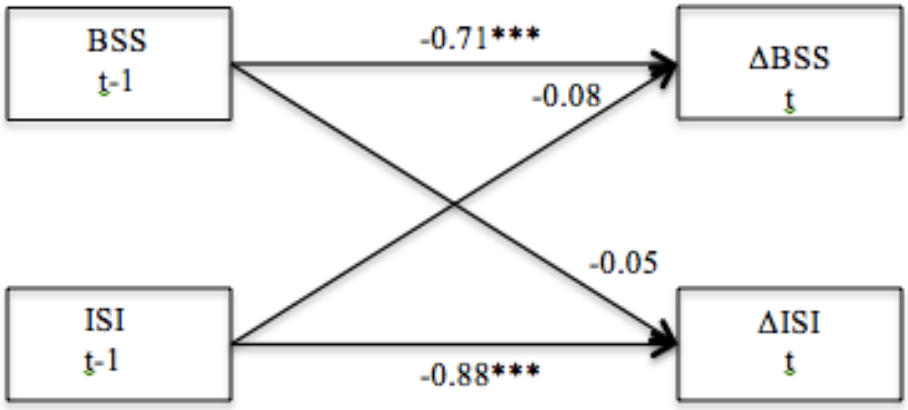

Figure 4. Cross-lagged panel over time of suicide ideation and insomnia predicting change over time with suicide status group as a moderator. Suicide status group did not interact with any of these effects.

***$p < 0.001$

DISCUSSION

This study sought to understand how insomnia symptoms change over time amongst suicide ideators, single suicide attempters, and multiple suicide attempters, as well as to explicate the relationship between insomnia and suicide risk over time in a longitudinal study of active duty Army personnel with suicidal thoughts and behaviors. Results of analyses revealed that suicide ideators, single, and multiple suicide attempters report similar baseline levels of insomnia and suicide risk; suicide status groups have similar trajectories in insomnia over time; and while insomnia and suicide risk change together over time, change in one does not predict change in the other.

Overall, these findings suggest that insomnia is a co-occurring problem with suicide risk for individuals with suicidal thoughts and behaviors, but it does not influence fluctuations in suicide risk. The present findings are consistent with the extant literature to the point that the methodological and statistical limitations of currently available research allow. The methods used in most studies reporting associations between insomnia and suicide ideation, whether they be retrospective (e.g., Bjorngaard et al., 2011; Krakow et al., 2011) or prospective (e.g., Chakravorty, 2014, Fawcett et al., 1990), have only allowed for conclusions of relationships between these variables. The present findings expanded on current knowledge and detected that insomnia and suicide risk change together over time. However, existing data have been unable to speak to the

influential nature of insomnia on suicide risk. Our 2 years of follow-up data failed to detect the lagged effects of insomnia on future changes in suicide risk.

Additionally, very few demographic or psychological differences were observed between the suicide status groups. Suicide ideators, single, and multiple attempters were of similar ages, genders were evenly represented, and all reported similar baseline levels of suicide risk. However, multiple attempters were more likely to have a history of non-suicidal self-injury. Other studies have found that these groups tend to be fairly similar, but that multiple attempters are more likely to have borderline personality disorder than suicide ideators or single attempters in military (e.g., Bryan & Rudd, 2015) and civilian samples (e.g., Boisseau et al., 2013). Approximately 90-91% of adults with BPD endorse histories of NSSI (Homan, Sim, Fargo, & Twohig, 2016; Zanarini, Frankenburg, Hennen, Reich, & Silk, 2006); therefore, it is possible that history of NSSI served as a proxy of BPD in this sample, explaining why multiple attempters in this sample were differentiated from the other groups by their NSSI-histories. Previous studies using civilian (Forman et al., 2004) and military (Rudd et al., 1996) samples have reported that multiple attempters experience more severe suicide ideation (often measured with the BSS) than suicide ideators and single attempters; however, the multiple attempters in the present study reported similar levels. This was true when attempters were grouped by their baseline suicide attempt status as well as their 18-month status. These findings continued to hold when removing NSSI-history as a covariate and using alternative statistical techniques. Additionally, the previously reported samples do not significantly differ in age or size from the present sample, and participants of this study with history of NSSI did not report more severe suicide risk at baseline than those without. It is possible

that this discrepancy is due to selected measures of suicide ideation. The BSS may differ in the construct it is measuring from other suicide ideation measures used by Rudd et al. (1996). Also, the results of a MANCOVA presented by Forman et al. (2004) comparing BSS scores of multiple and single attempters only approached significance. Therefore, this inconsistency may be due to selected measures, but needs to be explored further.

Together, results of this study illustrate the fluid nature of suicide risk and highlight that it is essential to examine within-person factors that influence suicide risk. Group-level factors lack specificity and may function differently between people. These conclusions are consistent with the Fluid Vulnerability Theory (FVT) of suicide (Rudd, 2006), which views suicide risk through a diathesis-stress model, stating that all individuals have a stable baseline risk for suicide and that sufficient aggravating factors can activate a suicidal mode (or suicidal state). Thresholds of activation of the suicidal mode vary from person-to-person, primarily as a function of their baseline risk. For this reason, suicide status should not serve as a primary or sole predictor of suicide risk, but may be included as a risk factor to add to individual risk models.

This study has several strengths, namely the use of a longitudinal design with relatively brief periods between assessments, and appropriate statistical techniques to analyze insomnia and suicide risk over time. Additionally, the recency of suicide intent and/or attempt at baseline helped to ensure that participants were able to accurately report their symptoms with self-report measures. Despite these strengths, several improvements could have been made to strengthen the validity of these findings. Primarily, the internal validity of the study could be improved with a greater number of assessment periods over closer time intervals. This may have allowed for identification of *imminent* risk factors

of suicide. Additionally, suicidal behavior (i.e.,, a suicide attempt) is the ideal outcome variable in these prediction models, as correlates and predictors of suicide attempt and suicide ideation are distinct (Klonsky & May, 2014). We instead chose a continuous measure of suicide risk that would allow for more in depth analyses of the available sample. Future studies aiming to predict suicide behavior should aim to complete measures over the course of the suicidal mode or immediately following a suicide attempt. Of course, both of these study designs introduce a number of methodological, and perhaps ethical, challenges. Additionally convergent measures of suicide risk, suicide attempt, and insomnia would have strengthened the construct validity of this study. Finally, the generalizability of these findings to nonmale Army personnel is unknown. Therefore, these analyses should be replicated in a variety of samples including females, civilians, and and/ or non-active-duty Army personnel.

The nature of the relationship between insomnia and suicide risk remains unclear. Results of the present study indicate that they change together; however, the precipitating factor(s) are still unknown. Future studies should seek to identify dynamic variables that predict this change as well as focus on predictors of suicide attempt.

APPENDIX

EQUATIONS

1. $ISI_{ij} = \gamma_{00} + \gamma_{01}*TX_j + \gamma_{10}*TIME\_T_{ij} + \gamma_{11}*TX_j*TIME\_T_{ij} + u_{0j} + r_{ij}$

2. $ISI_{ij} = \gamma_{00} + \gamma_{01}*TX_j + \gamma_{02}*SS2_j + \gamma_{10}*TIME\_T_{ij} + \gamma_{11}*TX_j*TIME\_T_{ij} + \gamma_{12}*SS2_j*TIME\_T_{ij} + \gamma_{20} + u_{0j} + r_{ij}$

3. $ISI_{ij} = \gamma_{00} + \gamma_{01}*TX_j + \gamma_{02}*SS1_j + \gamma_{03}*NSSI_j + \gamma_{10}*TIME\_T_{ij} + \gamma_{11}*TX_j*TIME\_T_{ij} + \gamma_{12}*SS1_j*TIME\_T_{ij} + \gamma_{13}*NSSI_j*TIME\_T_{ij} + u_{0j} + r_{ij}$

4. $ISI_{ij} = \gamma_{00} + \gamma_{01}*TX_j + \gamma_{10}*TIME\_T_{ij} + \gamma_{11}*TX_j*TIME\_T_{ij} + \gamma_{20}*TIME^2_{ij} + \gamma_{21}*TX_j*TIME^2_{ij} + u_{0j} + r_{ij}$

5. $ISI_{ij} = \gamma_{00} + \gamma_{01}*TX_j + \gamma_{02}*SS2_j + \gamma_{10}*TIME\_T_{ij} + \gamma_{11}*TX_j*TIME\_T_{ij} + \gamma_{12}*SS2_j*TIME\_T_{ij} + \gamma_{20}*TIME^2_{ij} + \gamma_{21}*TX_j*TIME^2_{ij} + \gamma_{22}*SS2_j*TIME^2_{ij} + u_{0j} + r_{ij}$

6. $ISI_{ij} = \gamma_{00} + \gamma_{01}*TX_j + \gamma_{02}*SS1_j + \gamma_{03}*NSSI_j + \gamma_{10}*TIME\_T_{ij} + \gamma_{11}*TX_j*TIME\_T_{ij} + \gamma_{12}*SS1_j*TIME\_T_{ij} + \gamma_{13}*NSSI_j*TIME\_T_{ij} + \gamma_{20}*TIME^2_{ij} + \gamma_{21}*TX_j*TIME^2_{ij} + \gamma_{22}*SS1_j*TIME^2_{ij} + \gamma_{23}*NSSI_j*TIME^2_{ij} + u_{0j} + r_{ij}$

7. $BSS_{ij} = \gamma_{00} + \gamma_{01}*SS1_j + \gamma_{02}*NSSI_j + \gamma_{10}*TIME\_T_{ij} + \gamma_{11}*SS1_j*TIME\_T_{ij} + \gamma_{12}*NSSI_j*TIME\_T_{ij} + u_{0j} + r_{ij}$

8. $BSS_{ij} = \gamma_{00} + \gamma_{01}*SS2_j + \gamma_{10}*TIME\_T_{ij} + \gamma_{11}*SS2_j*TIME\_T_{ij} + u_{0j} + r_{ij}$

9. $ISI_{ij} = \gamma_{00} + \gamma_{01}*TX_j + \gamma_{02}*SS2_j + \gamma_{10}*TIME\_18C_{ij} + \gamma_{11}*TX_j*TIME\_18C_{ij} + \gamma_{12}*SS2_j*TIME\_18C_{ij} + \gamma_{20}*TIME\_18C^2_{ij} + \gamma_{21}*TX_j*TIME\_18C^2_{ij} + \gamma_{22}*SS2_j*TIME\_18C^2_{ij} + u_{0j} + r_{ij}$

10. $ISI_{ij} = \gamma_{00} + \gamma_{01}*TX_j + \gamma_{02}*SS1_j + \gamma_{03}*NSSI_j + \gamma_{10}*TIME\_18C_{ij} + \gamma_{11}*TX_j*TIME\_18C_{ij} + \gamma_{12}*SS1_j*TIME\_18C_{ij} + \gamma_{13}*NSSI_j*TIME\_18C_{ij} + \gamma_{20}*TIME\_18C^2_{ij} + \gamma_{21}*TX_j*TIME\_18C^2_{ij} + \gamma_{22}*SS1_j*TIME\_18C^2_{ij} + \gamma_{23}*NSSI_j*TIME\_18C^2_{ij} + u_{0j} + r_{ij}$

11. $Change_{ij} = \gamma_{00} + \gamma_{01}*ind\_BSS_{ij} + \gamma_{02}*ind\_BSS_{ij}*BSS_{ij} + \gamma_{03}*ind\_BSS_{ij}*BSS_{ij}*status_{ij}\ \gamma_{04}*ind\_BSS_{ij}*ISI_{ij} + \gamma_{05}*ind\_ISI_{ij} + \gamma_{06}*ind\_ISI_{ij}*BSS_{ij} + \gamma_{07}*ind\_ISI_{ij}*ISS_{ij} + \gamma_{08}*ind\_ISI_{ij}*ISI_{ij}*status_{ij}\ u_{0j} + r_{ij}$

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